

Cooling Tower Subgroup Report

3/28/17

Introduction

Regulation #85, the Colorado Nutrients Management Control Regulation, established numeric nutrient effluent limitations for many domestic wastewater treatment plants and industrial wastewater dischargers that are likely to have significant levels of nutrients in their discharges. However, Section 85.5(3)(b) contained an exception stating that the effluent limitations would not apply:

Where noncontact cooling water discharges contain nutrients (phosphorus or nitrogen) and nutrients in the discharge originate from the receiving water as intake water or through use of chemicals shown to be necessary for proper operation of the cooling tower.

In addition, Section 85.6(2)(a) required cooling towers to monitor TP, TN, and TIN in the inflow, discharge, and any nutrient in added chemicals for two years. The Commission explained in the statement of basis and purpose that, in the triennial review of Regulation #85, it would use the data generated to determine whether it is necessary to control nutrient loadings from cooling towers through numeric effluent limitations or best management practices, or if the exception would continue.

To assist with the triennial review of Regulation #85 scheduled in October 2017, this report provides the following information about nutrient loadings from cooling towers:

- A data analysis summarizing nutrient concentrations and loads from cooling towers as reported pursuant to Section 85.6(2)(a).
- A comparison of nutrient loading from cooling tower discharges and domestic wastewater treatment plants (WWTPs).
- A summary of available information comparing the nutrient loads in cooling tower intakes and the added load in the effluent or blowdown, where load calculations were feasible.
- Summaries of nutrient data and operational descriptions from selected facilities representing a majority of the cooling tower discharge flow. These case studies are provided in Attachment 1.

Data Analysis

To better understand the relative contribution of nutrient loading from cooling tower discharges, summary statistics were calculated for the Regulation 85 monitoring data for cooling towers and domestic WWTPs. The Water Quality Control Division provided a summary spreadsheet of cooling tower data submissions, and Colorado State University provided summary statistics for the Regulation 85 data sets for domestic WWTPs accessible through eRAMS. Tables 1 and 2 and Figures 1 through 4 summarize these data sets. Some facilities had enough intake and blowdown/effluent flow and concentration data to estimate the added load from these facilities.

Figures 5-7 show these estimates. Observations and conclusions supported by this analysis include:

1. Nutrient discharges from cooling towers represent a very small fraction of nutrient loading to waterbodies in Colorado. For total phosphorus, the average daily loading from cooling towers is <1% of the combined total loading from domestic WWTPs and cooling towers. For total inorganic nitrogen, the average daily loading from cooling towers is approximately 2.6% of the combined total loading from domestic WWTPs and cooling towers. These fractions would be even smaller if other industrial (SIC 20) facilities were included in the total nutrient loadings statewide. Additionally, when considered on an annual loading basis, this estimate is conservative because many cooling tower facilities do not operate year-round, whereas most domestic WWTPs operate 12 months per year.
2. Despite this low overall loading, approximately half of the existing permit holders for cooling tower discharges would not be able to attain potential technology-based effluent limits for nutrients at one or more of their facilities without installation of treatment, typically due to elevated total phosphorus, although three facilities would also have difficulty meeting nitrogen limits. Unlike domestic WWTPs, these facilities are typically not equipped with treatment technologies for nutrient removal. Installation of these treatment facilities would involve substantial cost, with relatively little reduction in nutrient loading. Generalizations regarding which types of facilities have difficulty meeting these potential limits are not easily categorized along the lines of public, industry, small, large, etc. Therefore, there are not simple “bins” that could be used to create different permit conditions depending on facility category.
3. Several facilities had data suitable to evaluate the hypothesis that nutrient discharges are largely driven by intake (source) water quality, as opposed to chemical addition. For these facilities, findings included:
 - a. The facilities evaluated add little to no measurable nitrogen load (See Figures 6 and 7). For these facilities, elevated concentrations of nitrogen in the discharge are typically increased through concentration of nitrogen in the source water (e.g., water volume decreases, so concentration increases). For other facilities (e.g., MillerCoors), the small difference between intake water and effluent concentrations demonstrates that the nitrogen concentrations are almost entirely from the source water. Some facilities reduce the nitrogen loads. Therefore, as nutrient controls on domestic WWTP and nonpoint sources are implemented, the cooling towers’ source water nitrogen concentrations and effluent concentrations are expected to decline.
 - b. Some of the facilities evaluated add a small phosphorus load, while others reduce the phosphorus loads from the intake water (See Figure 5). For other facilities (e.g. MillerCoors), the small difference between intake water and effluent concentrations demonstrates that the phosphorus concentrations are almost entirely from the source water. Net phosphorus loads for the select facilities are modest.

4. Based on available data used in this report, source controls such as reducing chemical addition are not a simple solution for attainment of potential permit limits for certain facilities. Facilities generally utilize the minimum chemical addition necessary to maintain cooling tower operations for economic reasons.

Conclusion

The cooling tower nutrient data demonstrates that cooling tower discharges represent a very small portion of the added nutrient load in Colorado. In particular:

- Cooling towers contribute <1% of the total phosphorus loading of domestic WWTPs.
- Cooling towers contribute approximately 2.6% of the total nitrogen loading of domestic WWTPs.
- Many of the cooling towers contribute little to no measurable added load of nutrients. Instead, the majority of the nutrient load originates from the source water rather than chemical addition for facilities that had data supporting this comparison.
- Because of nutrients in the source water, some cooling tower facilities would be unable to meet the Regulation #85 effluent limitations for total phosphorus or total inorganic nitrogen.
- Although instream assimilative capacity may be available for some permitted dischargers, many of these facilities are downstream of existing domestic WWTP facilities and therefore would not benefit from water quality based effluent limitations that take into account assimilative instream capacity.

Based on the insignificant load added by cooling towers, we recommend that the Commission retain the cooling tower exception in Section 85.5(3)(b).

Table 1. Summary of Statewide Nutrient Loading for Cooling Towers and Domestic WWTPs

Statewide Data Reported to CDPHE	Sum of Average Daily Loads	
	TP (lb/day)	TIN (lbs/day)
WWTPs	5137	27985
Cooling Towers	41	748
Total	5178	28733
% Cooling Tower Load	0.8%	2.6%

Figure 1. Relative Cooling Tower and Domestic WWTP TP Loading

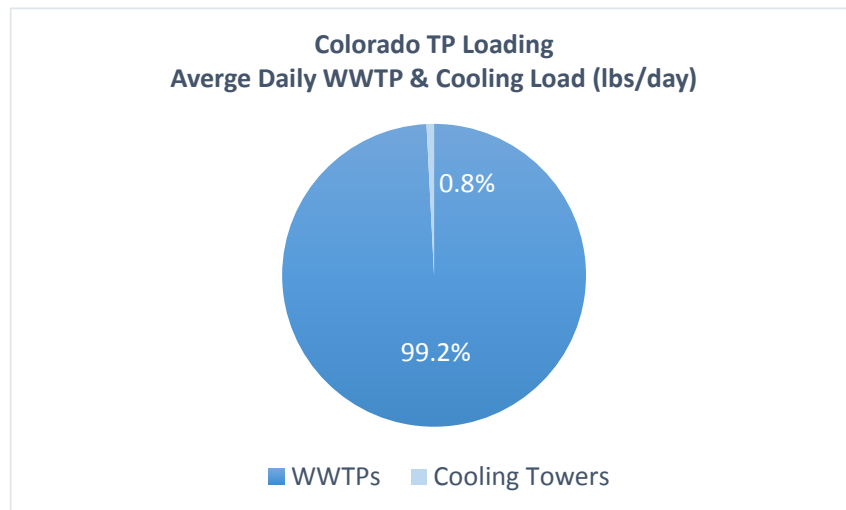


Figure 2. Relative Cooling Tower and Domestic WWTP TIN Loading

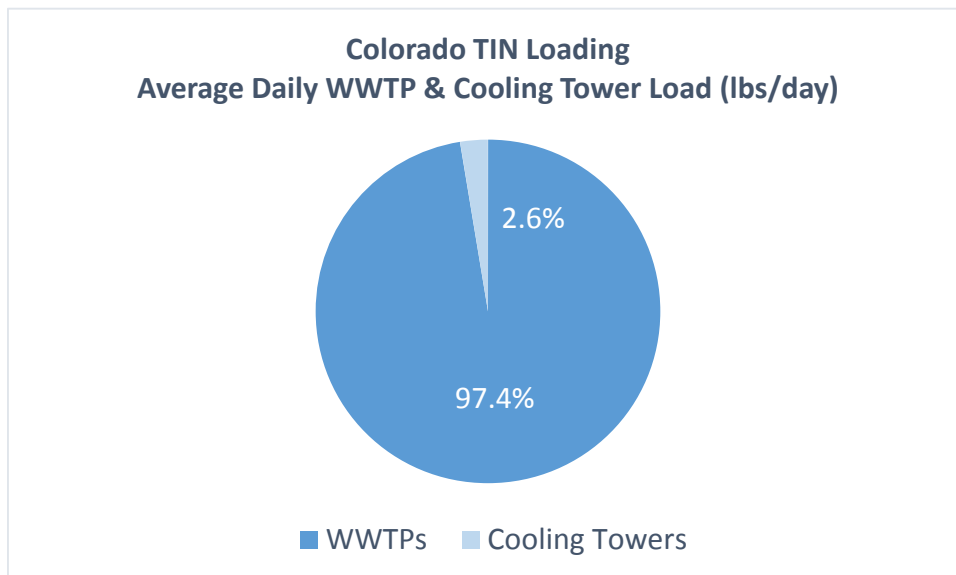


Table 2. Summary of Cooling Tower Discharges and Selected Domestic WWTP Data

Facility	Loads		Concentrations	
	Mean TP (lbs/day)	Mean TIN (lbs/day)	Median TP (mg/L) ³	Median TIN (mg/L) ⁴
Domestic WWTPs (for comparison)¹				
High Priority Wat.: WWTP > 2 MGD	3,100	21,600 (TN)	NC	NC
High Priority Wat.: WWTP > 1 & <2 MGD	80	780 (TN)	NC	NC
High Priority Wat.: WWTP < 1 MGD	170	45 (TN)	NC	NC
CSU 2017: All Domestic WWTPs	5,137	27,985	2.33	10.58
Cooling Tower Discharge				
Sum of Cooling Tower Loads (lbs/day)	41	748	NC	NC
Individual Cooling Tower Data ²				
ARAP3	0.36	0.68	0.62	1.10
Air_L	5.63	4.58	3.31	1.40
EVRAZ_BO	0.31	0.13	0.37	0.21
EVRAZ_DE	0.12	0.21	0.60	1.08
EVRAZ_EA	0.41	0.15	0.42	0.22
EVRAZ_VT	0.03	0.84	0.05	0.55
FRE_ETH	1.54	19.96	3.10	42.75
FountV_1	0.06	1.19	0.61	12.20
FountV_2	0.08	1.27	0.71	11.61
MCoors_11	2.62	73.88	0.01	0.26
MCoors_6	1.48	55.32	0.02	0.23
MCoors_7	6.11	152.86	0.01	0.29
MCoors_8	1.70	40.73	0.02	0.26
PSCO-FSV	11.83	89.27	3.00	24.16
PSCO_Cher	0.41	295.59	0.02	15.39
PSCO_Com	4.89	9.14	0.38	0.87
STER_ETH	0.59	0.01	3.52	0.001
TRINuc1-3	1.13	0.88	2.10	1.31
TRINuc4	1.86	1.47	1.91	1.43
TRI_Rif	0.08	0.01	1.94	0.24

Notes:

¹Domestic WWTP data for high priority watersheds are taken from the Division's 2015 Progress Report. The TIN column for the Division data reports TN, as summarized in the Division report.

CSU 2017 domestic data were provided by Colorado State University based on Reg. 85 data sets in eRAMS.

²Cooling tower facility names highlighted in yellow reported discharges > 1 MGD.

³Concentrations highlighted in pink exceed technology based effluent limit for existing facilities for total phosphorus (1 mg/L) per Regulation 85.5(1)(a)(iii)(a).

⁴Concentrations highlighted in pink exceed technology based effluent limit for existing domestic facilities for total inorganic nitrogen (15 mg/L) Regulation 85.5(1)(a)(iii)(b).

Figure 3. Average TP Loads and Median TP Concentrations for Cooling Tower Discharges

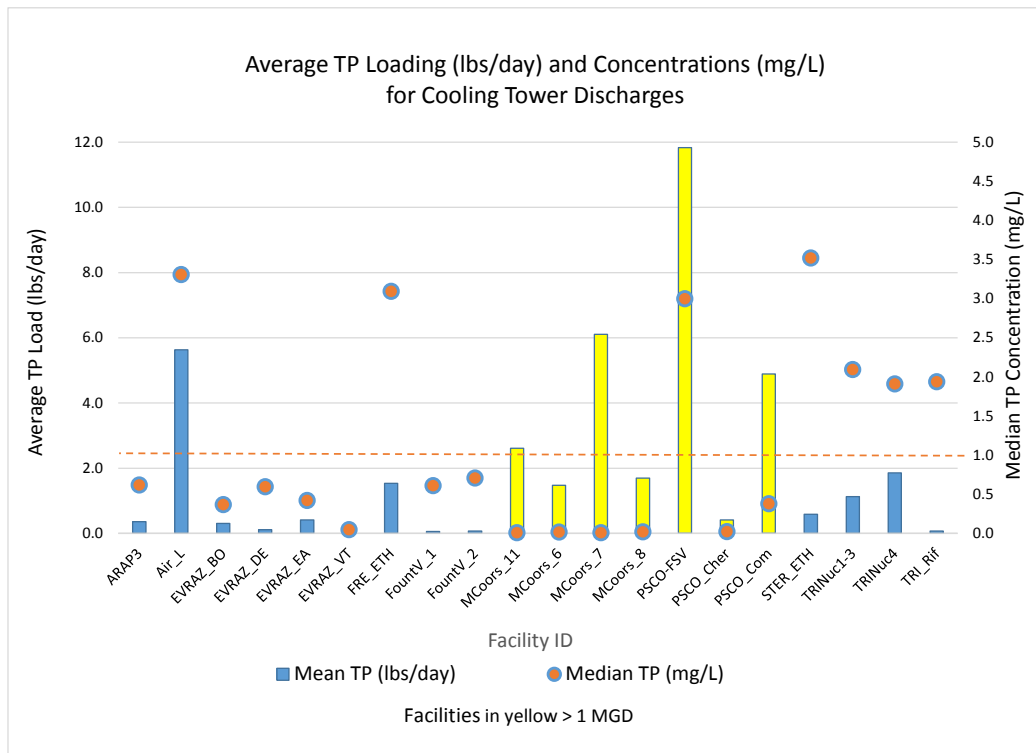


Figure 4. Average TIN Loads and Median TIN Concentrations for Cooling Tower Discharges

(Note: Loads are shown on log scale.)

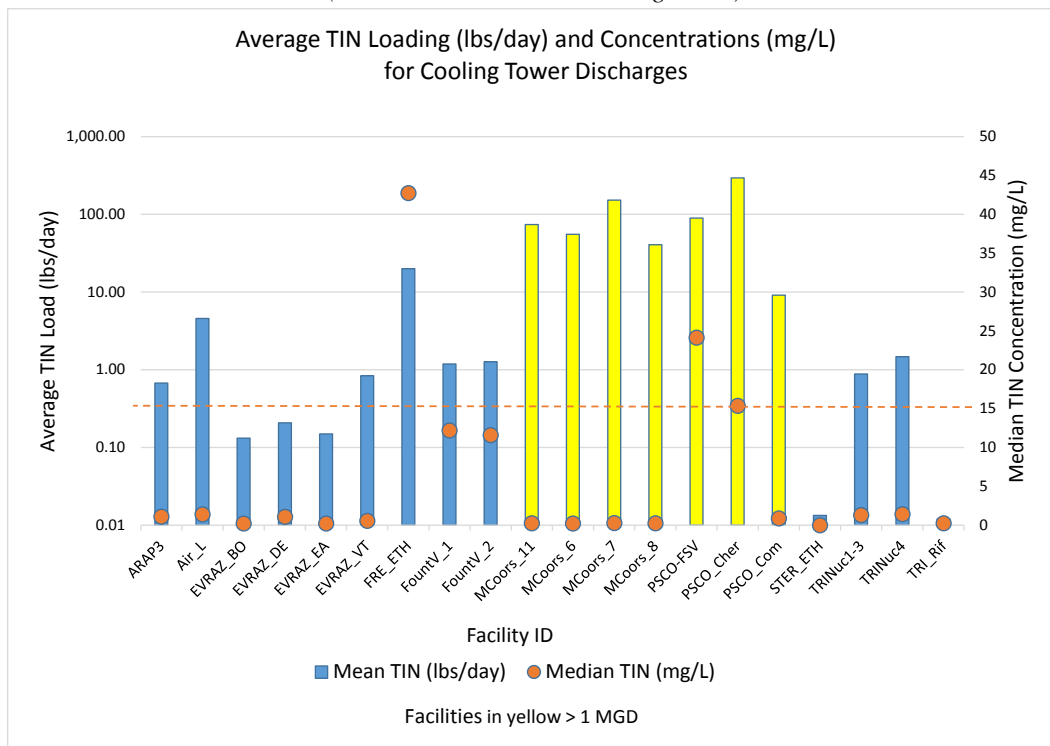


Figure 5. Average TP Loading for Select Facilities

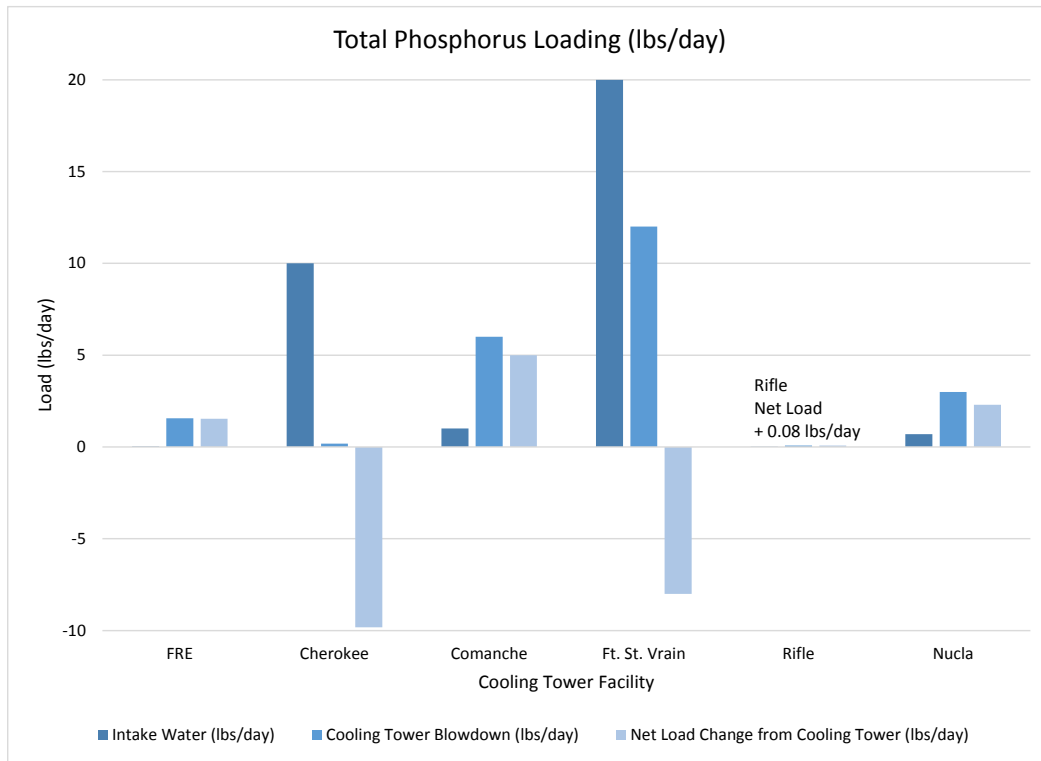


Figure 6. Average TIN Loading for Select Facilities

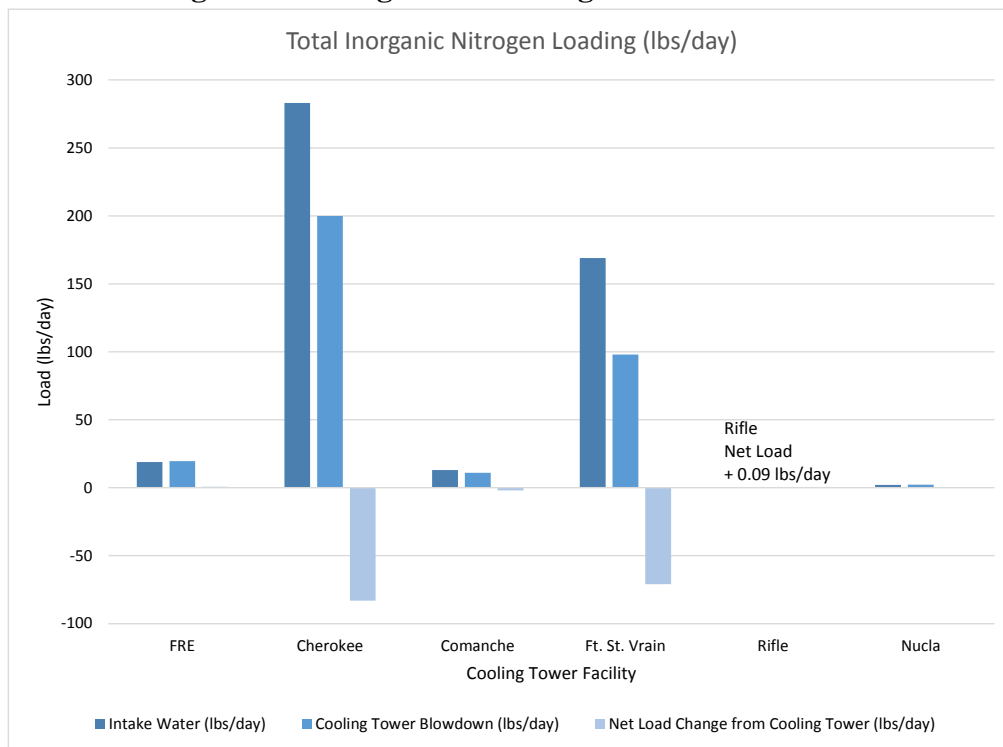


Figure 7. Average TN Loading for Select Facilities

